CARBON ON MERCURY’S SURFACE – ORIGIN, DISTRIBUTION AND CONCENTRATION. Rachel L. Klima (Rachel.Klima@jhuapl.edu)[1], Brett W. Denevi[1], Carolyn M. Ernst[1], Scott L. Murchie[1], and Patrick N. Peplowski[1]. [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA.

Introduction: Distinctive low-reflectance material (LRM) was first observed on Mercury in Mariner 10 flyby images [1]. Visible to near-infrared reflectance spectra of LRM are flatter than the average reflectance spectrum of Mercury, which is strongly red sloped (increasing in reflectance with wavelength). From Mariner 10 and early MErcury, Surface, Space, ENvironment, GEochemistry, and Ranging (MESSENGER) flyby observations, it was suggested that a higher content of ilmenite, ulvöspinel, carbon, or iron metal could cause both the characteristic dark, flat spectrum of LRM and the globally low reflectance of Mercury [1,2]. Once MESSENGER entered orbit, low Fe and Ti abundances measured by the X-Ray and Gamma-Ray Spectrometers ruled out ilmenite, and ulvöspinel as important surface constituents [3,4] and implied that LRM was darkened by a different phase, such as carbon or small amounts of micro- or nanophase iron or iron sulfide dispersed in a silicate matrix. Low-altitude thermal neutron measurements of three LRM-rich regions confirmed an enhancement of 1–3 wt% carbon over the global abundance, supporting the hypothesis that LRM is darkened by carbon [5].

Two explanations for carbon on Mercury’s surface have been proposed. The first suggests that carbon could be exogenic, delivered gradually by comets over Mercury’s history [6]. The second is an endogenic origin: any carbon that did not partition into the core of the planet would crystallize as graphite, and would have risen to the surface creating a primordial graphite flotation crust [7]. Across the surface of Mercury, LRM shows clear evidence of having been excavated from depth [8–11]. In cases where it is not clearly associated with specific craters, it occurs in patchy spots within broad regions of heavily cratered, ancient terrain where the ejecta from numerous small craters overlap [11–13]. This evidence, from global-scale mapping efforts, supports the hypothesis that this carbon is sourced from the remnants of a magma ocean flotation crust.

Although only three locations could be measured directly with the neutron spectrometer [5, 11], within uncertainty, there is a clear linear relationship between the average ~600 nm band depth for each LRM deposit. Based on the derived band-depth to carbon relationship, we estimated carbon contents for several LRM deposits (Fig. 1). Our results [11] suggest that some regions may contain as much as 5 wt% carbon above the global mean, a value consistent with the carbon content required to produce their low reflectances [9].

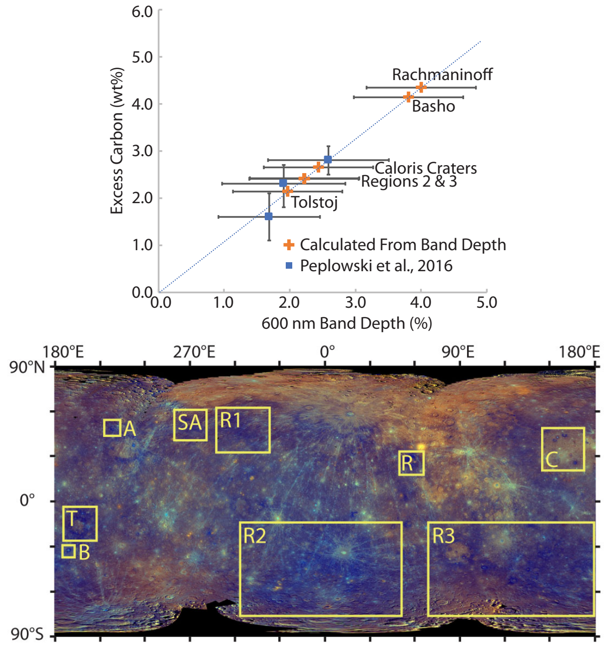

Fig. 1. (top) Extrapolated carbon content for different regions of the surface. Blue squares were measured directly in [5], orange plusses were calculated from the derived band depth relationship. **(bottom)** Enhanced color composite of Mercury with R=PC1, G=PC2, B=430/1000 nm slope. Locations of LRM-enriched craters measured in [5] A-Akutagawa, SA-Sholem-Aleichem, and R1-region LRM-A are shown, along with derived values for B-Basho, T-Tolstoj, R-Rachmaninoff and C-Craters within Caloris and two additional regional enhancements (R2, R3).

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